[Proc. Roy. Soc. Victoria, **54** (N.S.), Pt. I., 1942.]

Art. III.—*On the Thickness and Age of the Type Yeringian Strata, Lilydale, Victoria.*

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[Read 12th June, 1941; issued separately 15th April, 1942.]

Contents.

The Yeringian Series.

The Yeringian Series was named by Professor J. W. Gregory (1903, p. 172) in these words, "The second series we may call the Yeringian, after Yering, north of Lillydale, where the beds have yielded a small brachiopod fauna. These beds are best shown at Lillydale, but the name Yeringian is preferable, as based on a native Australian place name. This Yeringian series includes the most important silurian limestones, including those of Lillydale, Loyola, the Thomson River, Cape Liptrap, and also the beds of Seville and various localities in the basin of the Woori Yallock." Gregory referred the beds at Reefton, McMahon's Creek, Alexandra and Matlock to the Melbournian Series. Junner (1920) referred these beds, which he called "*Pancnka* Beds" to the Yeringian. Chapman (1913, 1924) instituted the Tanjilian Series to receive these same beds. Skeats (1928) showed that Chapman's sequence was incorrect and abandoned the name "Tanjilian". Chapman and Thomas (1935) accepted Skeats' correction of the sequence but defined the "Silurian" sequence of Victoria as "Keilorian, Melbournian and Yeringian", omitting the Tanjilian. They provide lists of fossils for the above three series but none for the Tanjilian. They do not include the characteristically Tanjilian fossils in either the Melbournian or the Yeringian lists. Thomas (1939) mapped the former Tanjilian beds with the Yeringian Series. The present writer (Gill, 1941) gave further grounds for rejecting the name "Tanjilian" and in re-defining the Series proposed the name "Jordanian". The Yeringian Series in the view of the present writer is the same in extent as originally given by Gregory. The latter thought there might be some Yeringian beds in the area east of Warburton (1903, p. 171, and section, Plate XXV., fig. 5), and this has proved to be so (Gill, 1941).

The fossils of the Yeringian Series have been described by McCoy, Etheridge, Cresswell, Chapman, Jones, Ripper, Hill, and others. Recently, the author (Gill, 1940*b*) contributed a paper extending our knowledge of the geographical extent and palaeontological content of the type Yeringian strata. A further paper (Gill, 1941) referred to the discovery of a fossiliferous conglomerate which is the southerly extension of a bed mapped by Jutson (1911). This conglomerate is considered to be possibly the base of the type Yeringian Series. The fauna is not well preserved, but the following forms have been noted:

COELENTERATA: Specimens of corals were sent to Dr. Dorothy Hill who has kindly made the following identifications—

Favosites sp. "reminiscent of *F. nitidus* Chapman".

Heliolites sp.

Heliolitids, possibly *Heliolites*. It could be *H. daintreei* but there is no possibility of proof.

Possibly *Prismatophyllum* but with more septa than *P. stevensi* and longer septa than *P. chalkii*.

A large simple rugose coral which could be *Mictophyllum*.

BRYOZOA:

Reptaria sp.

Other undetermined Bryozoa common.

BRACHIOPODA:

Camarotoechia sp.
"Chonetes" bipartita Chapman.
Chonetes sp. nov. (also at Lilydale).
Cyrtina sp.
cf. *Dalmanella elegantula* (Dalman).
Nucleospira cf. *marginata* Maurer.
Plagiorhyncha decemplicata (Sowerby).
Spirifer of *lilydalensis* Chapman type.

CRINOIDEA:

Abundant stem joints.

Favosites nitidus is known at Cooper's Creek in the Walhalla District (Chapman, 1914*c*; Jones, 1937) in beds of similar age to the Warrandyte South Quarry deposits. The writer has recently found this fossil (kindly determined by Dr. Hill) at Cave Hill, Lilydale. However, because of the imperfect preservation of the corals at Warrandyte, they are of little help in correlation.

The Bryozoan *Reptaria* has already been recorded from basal Yeringian beds near Yankee Jim Creek, Upper Yarra District (Gill, 1941) where it is associated with *Anoplia*. The author

has found this genus in a heavy conglomerate on the Yea-Alexandra road three-quarters of a mile west of Molesworth in a large cutting on the south side of the road. Also in the Merriang syncline (Yeringian) at Jutson's locality viii. (1908, Plate iii).

The brachiopods in the Warrandyte South Quarry conglomerate are of Yeringian aspect. Thus, although the fauna of the Warrandyte South Quarry (by which name it is proposed that the locality be known) is poorly preserved, the cumulative evidence of the fossils suggests a Yeringian age. The conglomerate and grit are quarried for road maintenance purposes, an excavation $6\frac{1}{4}$ chains long and 24 feet wide having been made. The quarry is long and narrow because the excavation has followed the conglomerate along the line of strike. The section at the southern end of the quarry shows 5 feet of conglomerate, then 5 feet of quartzitic grit, followed by another band of conglomerate 14 feet wide. The pebbles of the conglomerate, which are of all sizes up to 11 inches in diameter, are composed principally of quartz and quartzite. Some are of sandstone. The conglomerate is stratified, the beds dipping easterly at 70 degrees and striking north 15 degrees east. Jutson (1911, Plate xcii.) has mapped this conglomerate in its northerly extension. As Jutson has shown, the Warrandyte Anticline is surmounted at Warrandyte by a series of small folds. The conglomerate is repeated on these various folds. The present writer has found the conglomerate further south on the north side (half way down the hill) of the road which proceeds west across Anderson's Creek from the north end of Park Orchards (Military Map reference: Ringwood 236,421). Selwyn (1852) mapped a conglomerate still further south on the Mullum Mullum or Deep Creek. This has not been located.

When Gregory chose the Lilydale beds as the type strata for the Yeringian Series he did not define the limits of that series. It is suggested that the Warrandyte South Quarry conglomerate (a clear field horizon) may mark the lower limit of the type Yeringian Series. Selwyn (1856, p. 12) says, "The beforementioned fossiliferous limestone breccia and conglomerates are the only beds of a decidedly marked character in the whole area, which can be taken as a geological horizon and by means of which we may hope eventually to subdivide the palaeozoic strata of the Yarra basin into their upper and lower portions."

Another question to present itself is where, if at all, the conglomerate outcrops on the other side of the synclinorium which encloses the Yeringian beds of the Lilydale, Seville, and Killara districts? Attention is drawn to the conglomerate at Narbethong mentioned by Junner (1914*b*) and Edwards (1932). From this locality fragmentary fossils of a Yeringian character were obtained (Edwards, 1932, pp. 52-53).

The conglomerate at Warrandyte South may be compared with the Yeringian basal conglomerate and grits of the Walhalla synclinorium described by Herman (1901), Whitelaw (1916), Junner (1920), Baragwanath (1925), and Skeats (1928). Lenticles of limestone are associated with these beds. A conglomerate at Heathcote has been regarded as basal to the Yeringian Series (opinion quoted by Thomas, 1937, p. 67).

Like the Walhalla basal conglomerate and grit, that at Warrandyte South Quarry contains limestone, although in this case it is decalcified in the exposed part. To the south, half a mile west of the Scoresby State School, the Geological Survey collected in 1927 some fossils in impure barytes which were considered to be replacements of limestone fossils. Dr. Dorothy Hill examined these but was not able to discover in them any sure coralline structure. It is interesting in this connection to note the recording from Woori Yallock of calcareous fossils in barytes by Mitchell (1930). Through the kind help of Mr. F. S. Colliver, who assisted Mr. Mitchell in the collection of these fossils, I was enabled to examine the specimens referred to in Mitchell's paper. They include the following forms:

Favosites sp.
Lindstroemia cf. *yeringae* Chapman.
Orthoceras sp.
Conularia sp. (fragment carrying typical ornament).
Beyrichia sp.
Numerous crinoid stem joints.
Brachiopod fragments.

Thus in the Yeringian Series of the Lilydale and adjacent areas there is pure limestone at Cave Hill, impure limestone (60 per cent. silica, 30 per cent. calcium carbonate) at Seville (Cresswell, 1901), decalcified limestone in the Warrandyte South Quarry conglomerate, limestone replaced by barytes at Woori Yallock, and possibly the same at Scoresby. According to Gregory (1903, p. 170) the limestone occurrences are characteristic of the Yeringian strata.

The Thickness of the Type Strata.

Selwyn (1852) was the first to publish data concerning the structure of the type Yeringian area. He made a chained and levelled section from 1½ miles west 15 degrees south of Kinlochue Inn, Sydney road, Parish of Mickleham, to Mount Corhanwarabul, near Mount Dandenong. This section showed a large synclinal structure through the Lilydale district. Gregory (1903) called this the "Lilydale Synclinal", making the following comments: "East of this Melbourne fracture zone the beds have

a regular dip to the west. This slope is a part of a great anticlinal, of which the axis passes through Warrandyte. Along this anticlinal axis there is another line of contortions and faults, along which occurs a series of auriferous quartz reefs. The eastern leg of the anticlinal is much steeper than the western; and beyond it we come to the great synclinal which passes through Lillydale and Yering. We will therefore call it the Lillydale Synclinal." Jutson (1911) worked out the structure of the Warrandyte anticlinorium (to the west of Lilydale) and computed the thickness of the rocks on its eastern limb as being between 14,000 and 15,000 feet. Later, Jumner elucidated the structure of the rocks to the north-west (1913) and north (1914) of Warrandyte. Thomas (1939, p. 62) contributed the following comment on the structure of the rocks: " Between the Starvation Creek and the Lilydale outcrops the general structure seems to be synclinal, and this may be termed the Lilydale-Warburton synclinorium. The graptolite localities at Macclesfield show more complexity than is indicated in this general statement, and it may be advisable to separate the Lilydale from the Warburton synclinorium. In any case the extension eastwards of the Wallhalla beds is a great help in picturing the general structure of this part of Victoria, which forms the Lilydale synclinal of Gregory . . . . . West from Lilydale the principal anticlines are those of Warrandyte, Templestowe, and Whittlesea, and in each of these Melbournian fossils have been recorded. It is a sad commentary on the state of our knowledge that we are unable to show the boundary between the Melbournian and Yeringian in this part of Victoria, i.e. between the type areas." One finds it difficult to follow Thomas' interpretation of the structure between Starvation Creek and Lilydale. To begin with, these two localities comprise beds of different ages. The Starvation Creek beds are Jordanian, while the Lilydale beds are Yeringian. The Toscanite screens part of this section but to the north the Yeringian beds on the View Hill Creek give evidence of their continuance. Probably there is a synclinorium between Warrandyte and Warburton, as already suggested.

The wide extent of the Yeringian beds may well be due to their repetition caused by a strongly pitching anticlinorium which brings up Melbournian beds in the Macclesfield area. Edwards (1940) surmised the presence of a brachy-anticlinorium. This will be proved if Yeringian beds are found to the south. Hall (1914) recorded *Monograptus priodon* from Macclesfield. Mr. R. A. Keble and the present writer found *Monograptus* on a road which proceeds west from the Macclesfield-Woori Yallock road on the north side of allotment 98, Parish of Nungana. The specimens were obtained from a cutting on a rise about $\frac{1}{4}$ mile west from the Macclesfield-Woori Yallock road. These *Monograptus* beds are Melbournian and occur on an anticlinal axis.

Further north at Yellingbo Yeringian fossils have been collected, viz.:

Anoplia australis, sp. nov.
"Chonetes" bipartita Chapman.
Nucleospira australis McCoy.
Hyolithes sp.

The locality is a low cutting on the road running west from the picnic ground beside Woori Yallock Creek, about ¼ mile from the creek. The dip is 53 degrees northerly and the strike east 15 degrees north.

In the quotation already given, Thomas states that Melbournian fossils have been recorded in the Warrandyte anticline. Chapman also made this claim (1914*a*, p. 209). The present writer (1940*b*) has shown that the fossils from Anderson's Creek do not determine the age of the beds, and further (1941) that there is a conglomerate with Yeringian fossils at or near the axis of the Warrandyte anticline. The Anderson's Creek conglomerate (Selwyn and Ulrich, 1866, p. 12; Murray, 1887, p. 44; Jutson, 1911, p. 521) is apparently the same as that at Warrandyte South Quarry. The same *Spirifer,* bryozoa and crinoids are found at both localities. The conglomerate appears to be repeated over the small anticlines and synclines which crown the Warrandyte Anticline in the vicinity of the Warrandyte township. Thus the conglomerate is about the oldest horizon on the Warrandyte anticline, which is therefore Yeringian and not Melbournian as formerly supposed.

Gregory (1903, p. 172) was surprised that the Lilydale beds could not be found on the western limb of the Warrandyte Anticline. They are not repeated there, the reason being that there is too great a thickness of rocks on the eastern side for all of them to be repeated on the rising synclinorial folds of the western side. Jutson (1911, p. 532) found a difference in the thickness of beds on the two limbs of the anticline. As Gregory and Jutson noticed, the dips on the whole are steeper on the eastern side than they are on the western side. Unfortunately, the rocks from the axis of the Warrandyte anticline as far as the Brushy Creek escarpment are practically unfossiliferous; these are the beds which are repeated on the other side of anticline. In an earlier paper the author (1940*b*) described some laminated fossiliferous quartzites from the Yarra-road (locality 19 on the map). Similar beds occur in a road cutting at the southern end of Dublin-road, Ringwood East, and in cuttings at the northern ends of Lumm's and Jell's roads, near Wheeler's Hill. These contain the same kinds of fragments seen in the Yarra-road rock, but only crinoid stem joints were definitely identified. However, it seems likely that these are three outcrops of the same strata. The matrix is a particularly distinctive one. This same matrix

(which is presumed to be the same strata) has been found near the axis of the Bulleen Syncline, viz., on Williamson's-road, ¼ mile north of its junction with the road proceeding north from Doncaster (Military Map reference 157, 409). At this locality the following fossils have been found:

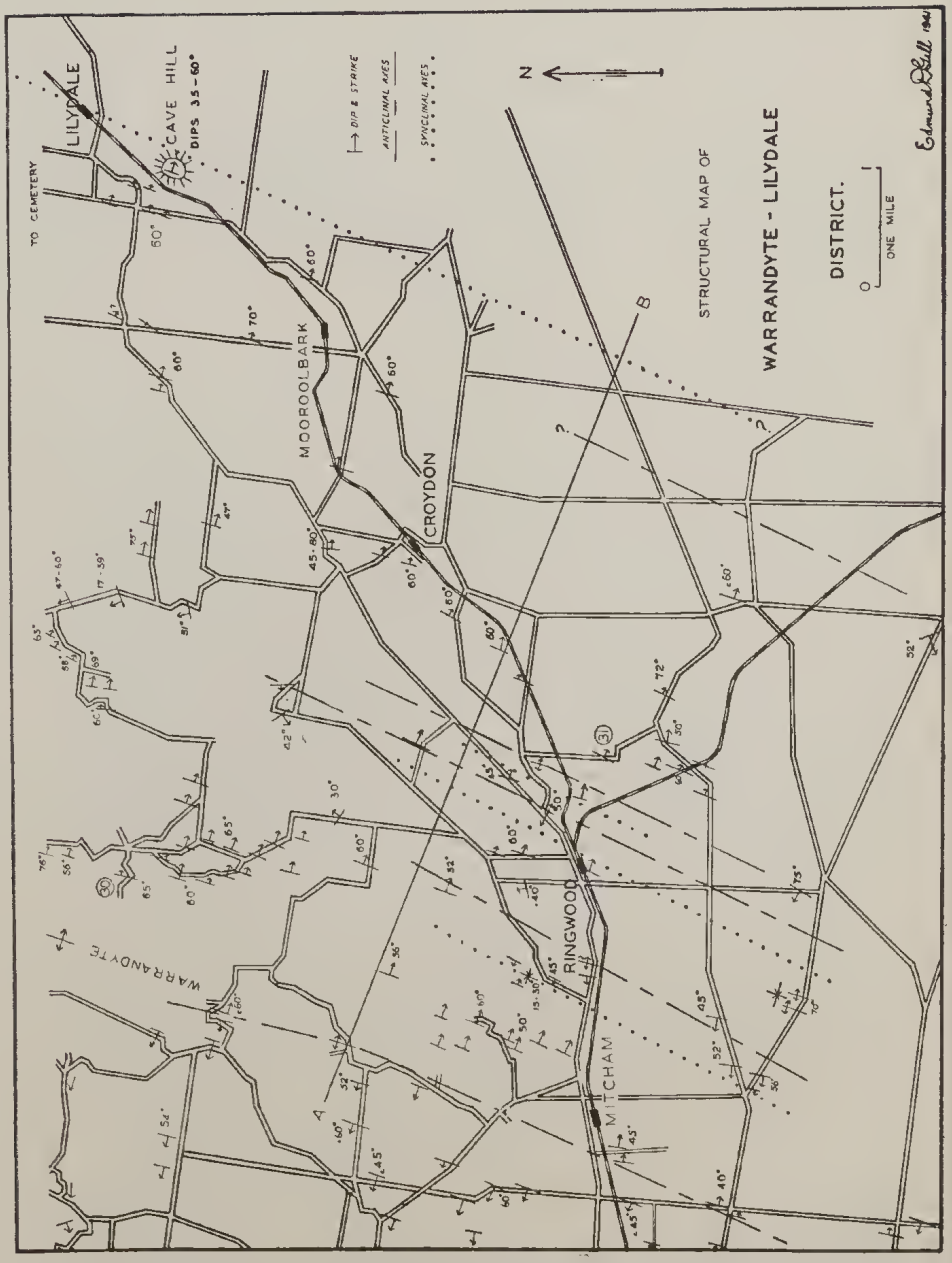
Nucleospira cf. *marginata* Maurer.

Chonetes sp.

Abundant brachiopod and crinoid fragments.

At the four localities where this same matrix is known the crinoid stem joints are common and of a small diameter with a simple pattern. This may be considered to be characteristic of the beds and a help in correlation. Thus there is some structural, lithological, and palaeontological evidence for assuming that the almost unfossiliferous beds from the axis of the Warrandyte Anticline to the Croydon scarp are the beds repeated on the western limb of the anticline. Because of the mounting of the folds in anticlinorial fashion to the Templestowe anticline on which the oldest beds of the series outcrop, the fossiliferous Lilydale beds do not appear again. That the beds of the Templestowe Anticline are the oldest is shown by the collection of *Climacograptus* and *Diplograptus* from the Diamond Creek mine (Junner, 1913), and of *Illaenus jutsoni* from west of Templestowe (Chapman, 1912). This palaeontological evidence agrees with the conclusions reached from the geological sections drawn by Selwyn (1852), Junner (1913), and Nicholls (1930).

The map accompanying this paper shows a number of features not previously known. The mapping of the area has shown that the principal structures shown by Jutson are substantially correct. The Warrandyte Anticline and the Bulleen Syncline have been traced southwards to where they disappear under the Tertiary sands in the vicinities of Notting Hill and Carnegie respectively. The Warrandyte Anticline passes through Springvale-road at Tunstall, about half way between Canterbury-road and Central-road (the next parallel road further north). Passing through Tally Ho it crosses Waverley-road between the termini of Stephenson's-road and the road just east of it which runs from Waverley-road to Ferntree Gully-road at Notting Hill. On this last-mentioned road easterly dips appear in a road cutting just north of Scotchman's Creek, while a few hundred yards further west there are westerly dips in a big quarry (marked on the Military Map). Between these two adjacent points the axis of the Warrandyte Anticline passes. The Bulleen Syncline cuts Serpell-road at Templestowe about half way between Williamson's-road and Church-road (the next parallel road further east). Further south it runs through Mont Albert in the vicinity of the railway station. Further south still it crosses the railway line between the Burwood and Ashburton railway stations.



The roads and railways have been drawn from the Military Map (Ringwood Sheet, 1935). The dips and strikes were measured during the past two years, and 7 degrees has been added to the magnetic readings as the map is meridional. The area of structure actually mapped extends for some miles in all directions beyond the borders of the map in fig. 2. Only the mapping needed to indicate the thickness of rocks in the synclinorium is presented. Some other data are provided in the text. A few dips and strikes have been taken from the map of Ringwood and Warrandyte by Moon (1893). Some dips and strikes in the northern part of the area are readings kindly made available for me by Dr. F. A. Singleton. The numbers 30 and 31 refer to the fossil localities "Warrandyte South Quarry" and "Dublin Road, Ringwood East" respectively. These numbers follow on those given on a previous map (Gill, 1940*b*, fig. 1, p. 252). The position of the axes of the synclines and anticlines are only approximate in some cases. However, the detailed evidence of dips and strikes is given so that the extent of possible variation is clear.

The exact location of the Lilydale Syncline is not known, and so it is marked with a question mark on the map. The text provides knowledge of its location further to the north and it is surmised that it continues in the same general direction to the south. The westerly dip in the south-east part of the map suggests the presence of an anticline but the flat country further north is devoid of outcrops, so the axis shown in the map is marked with a query. This part of the mapping is unsatisfactory, but all the data available have been collected.

Nicholls (1930) has traced the Blackburn Anticline as far south as Oakleigh. Its eastern limb is seen in the north as strong easterly dips on both sides of Blackburn-road in a cutting marked on the Military Map (reference 422,380), 1½ miles north of Blackburn. The anticlinal axis can be seen (not marked on Nicholls' map) on Burwood-road, half a mile west of Middleborough-road. At the west end of the cutting in which this axis appears, there is a decomposed dyke 18 inches wide containing whitish phenocrysts. It is associated with a change of dip from 52 degrees west to 18 degrees west. The Ringwood Anticline has been traced southwards through Vermont and Glen Waverley to Springvale.

From the better-known structures further west we come to Lilydale itself. Gregory gave the name "Lilydale Synclinal" to the synclinorium enfolding the Yeringian type strata. I propose that the name "Lilydale Syncline" be given the structure in which are the well-known Lilydale limestones. This syncline is a little east of Yarra Glen in the north (where there is a strong southerly pitch), west of "Flowerfield" Quarry, west of Yering Railway Station, and a little to the east of Cave Hill Quarry. The comparatively low dips at north of Lilydale, "Flowerfield" Quarry, and Yering Railway Station may be due to proximity of the synclinal axis. The buckling of the strata seen at the northern end of Cave Hill Quarry where the dip is lessened from 60 degrees to 35 degrees may be due to the same cause.

Jutson (1911) has described a zone of closely approximated anticlines and synclines at Warrandyte. A similar zone occurs at Yering Gorge and another at Ringwood East, most of the structure of the last-named area appearing on an old Geological Survey map (Moon, 1893). A fold not previously recorded has been observed in the cutting on Victoria-road just north of the Lilydale cemetery. These beds dip to the west while the strata in the cemetery dip to the east. At the adjacent locality "west of Lilydale Cemetery" (see map, Gill, 1940*b*), the rocks, as far as can be ascertained, also dip to the east. The rocks are decomposed but a harder band of quartzitic sandstone with its fossils gives a fairly definite indication of an easterly dip. Further west at Ruddock's Quarry easterly dips occur. To the south there are a number of outcrops, yet no sign of this anticline can be found, unless the westerly dip at Boronia shown at the southern limit of the map is a continuation of the same structure. At the fossil locality north of Lilydale there is a fauna comparable with that at "Flowerfield" quarry and cutting. However, the first-named locality is more than a mile west of "Flowerfield." It may be that the anticline observed in the Victoria-road cutting continues to the north, and that over it the north of Lilydale horizon is repeated at "Flowerfield." Paucity of outcrops prevents the observation of detailed structure in this area.

In the area under consideration, a feature of some note is the marked difference in physiography between the country south of the Mitcham axis (Hills, 1934, p. 174), and that north of it. This is very noticeable if a contoured map, such as the military map for Ringwood, is examined. In the north the contour lines are crowded together, while in the south they are much more spaced. The general lithology of the northern area is correspondingly different from that of the south. The rocks of the former area are much more indurated. Whitelaw (1895) explained this as being due probably to the proximity of an intrusive igneous mass. Dykes are common in the area. It is noticeable that the gold-mining fields (Warrandyte and Queenstown) are restricted to the indurated country. To the many records of dykes already made, two more are now added in view of their interest and significance. First, there is a dyke of sericitized felspar porphyry (Univ. Coll. Rock Sections, No. 5185) in the Yering Gorge, where, after half a mile of straight course, the river turns east at right angles in a series of rapids (Military Map reference 342.515).

The second dyke is of quartz porphyry, and outcrops on the Brushy Creek-road near the River Yarra at the northern extremity of the Brushy Creek escarpment. It is at the top of the hill which slopes down steeply to the river on the north and to Brushy Creek on the east. This dyke is at the northern end of Jutson's "Brushy Creek Fault" (Jutson, 1911) the existence of which was questioned by Hills (1934). This dyke accounts for the supposed larger throw of the fault at this point. However, if the fault is a dip slip strike fault as thought by Jutson, and the throw of the fault is of the dimensions he describes, then even if it is present, it will not affect very much the computation of the thickness of the strata, seeing that such a great thickness of rocks is involved. An examination of the area has revealed no major faulting. If the Warrandyte South Quarry conglomerate is regarded as the base of the Yeringian strata, and the thickness of the series measured along the line A—B on the map (fig. 2), the series is seen to be of considerable thickness. The average dip is estimated at 45 degrees, although often the dips measured were in the vicinity of 60 degrees, there were many of about 45 degrees and quite a number lower still (e.g., Ruddock's Quarry; in the vicinity of Ringwood: Wonga Park-Warrandyte road; and in the vicinity of Mitcham). There are also occasional rolls or monoclines as seen in the big quarry on the N.E. side of Loughnan's Hill, Ringwood, and in the quarry off the Heidelberg-road west of Warrandyte. In addition, there are minor folds (see S.W. area of map) to take into account. The almost east-west strike seen half a mile north of Ringwood suggests a small pitching fold. The sum distance of country over which easterly dips prevail is estimated from present evidence as approximately 4·3 miles. This gives a thickness of

3·04 miles of strata or 17,000 feet. This must be regarded as the maximum thickness, the actual thickness being quite probably less than this figure. Were it not for Moon's map (1893), we would not now be aware of the structure which exists at Ringwood East. There were formerly brick pits and a kaolin mine in that area, which facilitated the study of the structure. It may be noted that Selwyn (1852) shows a west dip on the Brushy Creek, west of Lilydale. The author has been unable to detect the syncline which such a dip infers. There is so much alluvium in the area that it screens the bedrock, and the gentle hillslopes provide no instructive outcrops. There are other considerable areas where no outcrops are to be found. The possibility of much more structure existing than has been found must be borne in mind. The seeming absence of structure between Croydon and Lilydale is remarkable, as there are signs of folding further north (Victoria-road cutting near Lilydale cemetery) and further south (Boronia). Moreover, on the eastern side of the Lilydale syncline there are folds not far from the axis, as can be seen north of the toscanites. The thickness of rocks in the Lilydale synclinorium may then be regarded as being between 10,000 and 15,000 feet, but more outcrops are needed for a more accurate calculation.

This thickness of type Yeringian strata may now be compared with the thickness of Yeringian rocks in other parts of the State.

(*a*) Walhalla:—In this district there is a thickness of 10,000 feet of Yeringian beds (Baragwanath, 1925). As these beds lie in a synclinorial fold, their precise original thickness cannot be measured. This applies to most of the Yeringian deposits.

(*b*) Heathcote:—There is a thickness of 12,000 feet above the Melbournian, according to Thomas' calculations (1937, p. 64). The top of the formation is faulted out of sight so that the full thickness of the series is not known. The Dargile beds are obviously Melbournian, as is shown by their graptolite content. The Mt. Ida beds are typically Yeringian. In between the Dargile beds and the Mt. Ida beds are the Melvor beds, the precise correlation of which is not yet clear. They may correspond to the lower unfossiliferous strata of the type series, or they may constitute a more littoral facies of the Jordanian, much of which is pelagic, or thirdly, they may prove to be correlative with both. However, shelly beds in the Jordanian have only recently been discovered, and the fauna of the Melvor beds at Heathcote has not yet been worked out, so no dependable conclusions can be reached.

(*c*) Whittlesea:—Jutson (1908) computed the thickness of the Yeringian rocks at Whittlesea to be 750 feet. The original thickness of the series in this area cannot be accurately estimated

because the extant beds are a remnant preserved in a synclinal structure. Nevertheless, the actual thickness at present persisting appears to be more than Jutson stated. The so-called Passage Beds are definitely Yeringian, as is plainly indicated by the presence of *Pleurodictyum megastomum, Stropheodonta alata, Actinopteria boydi,* &c. Indeed, all the specific determinations given by Chapman (p. 221), in his appendix to Jutson's paper, of fossils from the Yeringian beds at Whittlesea (except *Plagiorhyncha decemplicata,* which is also Melbournian) are contained in the beds he classifies as Passage Beds (p. 220). In addition, there is a number of other definitely Yeringian forms, as *Stropheodonta alata, Rhynchotreta cuneata, Actinopteria boydi, Phacops* cf. *sweeti,* and *Dalmanites meridianus.* Moreover, Jutson has drawn a fault in his section where the dips on his own map show an anticline to be present, apparently with a pitch to the north. The difference in strike on the two sides of the anticline, to which Jutson appeals as evidence of faulting, is no doubt due to the asymmetrical character of the pitching anticline, the dips being 8 degrees and 10 degrees on the west side, whereas they are 40 degrees and 50 degrees on the east side. The pitch would give the differential strikes. The most variant strike (N. 40 degrees E.) is on the side of the structure which has the low dips, this is to be expected if the foregoing interpretation of Jutson's map is correct.

Recently a traverse of Jutson's section was made by Mr. R. B. Withers and myself. West of the Eden Park-road, at a point just south of the bend to the east, a big washout in the creek showed a strong easterly dip prevailing in the bedrock. An easterly dip was also observed on the Eden Park-road a little north of the bend referred to. The creek outcrop shows that the axis of the anticline (which occurs where Jutson has a fault) does not run north–south, but veers to the west more or less parallel with the axis of the Whittlesea anticline. This accords well with the dips shown to the north of Jutson's map. The strike of the beds indicates that this holds also for the axis of the Merriang syncline. One implication of this revised picture of the structure is that Jutson's localities VI. and VII. are not two points of outcrop on the same line of strike (as shown on Jutson's map), but outcrops of the same bed on the two sides of an anticline. Locality VI. is nearer the axis than locality VII. because of the much higher dips on the east side of the anticline. If all the beds from the axis of this anticline to the axis of the Merriang syncline are Yeringian, then there is a thickness of some 1,200 feet present.

(*d*) Kinglake:—Mr. R. B. Withers informs me that there is a great thickness of Yeringian rocks in this area, but the actual figure has not yet been worked out.

The Age of the Type Strata.

The following table sets out the ages attributed to the type Yeringian strata by various authors:—

TABLE 1.

Author.	Locality.	Attributed Age.
Selwyn, 1852	On line of section ..	"This series contains numerous fossils of Silurian and Devonian forms"
McCoy, 1876	Sect. XII, Parish of Yering	"Probably identical with the May Hill Sandstone"
McCoy, 1877	Yering shale	Wenlock "= Lower Helderberg"
Etheridge, 1890	Cave Hill limestone ..	Upper Silurian, i.e., the present Silurian
Cresswell, 1893	Whole series	Silurian
Gregory, 1903	Whole series	Silurian
Chapman, 1913, p. 209 ..	Lilydale shales	Wenlock
Chapman, 1913, p. 211 ..	„ „ ..	Wenlock and Lower Ludlow
Thomas and Keble, 1933 ..	Whole series	Wenlock
Withers and Keble, 1933, p. 235	Lilydale mudstone ..	Wenlock
Chapman and Thomas, 1935	Whole series	Silurian, with Devonian elements
Ripper, 1938	Cave Hill Limestone ..	Lower Devonian
Hill, 1939	„ „ „ ..	Lower or Middle Devonian
Jones and Hill, 1940 ..	„ „ „ ..	Lower or Middle Devonian

The early computations of age were made on rather slender objective evidence, and so the results were necessarily of limited value. Later researches appear to have been influenced by these earlier findings. Until the recent studies were made, the age of the beds was accepted as Wenlock. Although Chapman regarded the Lilydale beds as Wenlock, he recognized some Devonian elements in the fauna (1908, p. 8; 1914*a*, p. 232). The acceptance of the Wenlock age-determination as a premise by Thomas and Keble (1933) vitiated their argument that the Melbournian series is younger than the Yeringian series. The Melbournian beds are certainly younger than Wenlock, as is shown by their graptolite content (Jones, 1927; Thomas and Keble, 1933). However, the Yeringian series is not Wenlock in age—a conclusion upon which Thomas and Keble depended (pp. 79, 81). Nevertheless, the implications of their work are important. They extended the graptolite evidence brought forward by Jones (1927), and established the Lower Ludlow age of the type Melbournian beds. The Yeringian beds overlie the Melbournian strata, and therefore must be younger than Lower Ludlow. In 1929, when describing the Reefton (Lower Devonian) beds of New Zealand, Allan (1929, p. 323) offered a criticism of the age-determination of the Yeringian in these words, "The Yeringian stage in Victoria is not a clearly defined unit, and any exact correlation thereof with the Silurian sequence of Great Britain must be considered entirely provisional. In this connexion the importance of facies has not been fully appreciated by Australian geologists."

In 1938, when describing the Baton River (Lower Devonian) beds of New Zealand, Shirley (1938, p. 492) wrote, "This fact (viz., the occurrence of *Pleurodictyum megastomum* and *Receptaculites australis* in Victoria) coupled with the statement mentioned by Dun in the introduction to the present work (viz., that the Baton River fossils are comparable with the Yeringian ones) suggests that the Yeringian contains at least one fauna similar to that of the Baton River series." Shirley also wrote (p. 499), "The identity of two species in the Baton River fauna with species from the Yeringian formation of south-eastern Australia, usually referred to the Wenlock, suggests that the age of some portion at least of this formation requires revision."

Ripper, after making detailed studies of the stromatoporoids of Lilydale (1933, 1937*a*) and Loyola (1937*b*) wrote a paper on the stratigraphical implications of this work (1938). She concluded that the Lilydale limestone is probably of Lower Devonian age. It is interesting to note that although McCoy referred Yeringian fossils to the Wenlock, he considered that to be equivalent with the Lower Helderberg of North America (1877, p. 24). Hill (1939), after studying the corals, came to the same conclusion regarding the age of the Lilydale limestone as Ripper had done, but added that strong Middle Devonian elements were present. This finding was accepted only with some degree of reserve. It was thought that there may have been instances of precocious evolutionary advance in that habitat, but that this advance was confined to those particular ecological conditions. In other words, it was thought that the limestone lenticle might carry Lower Devonian fossils but that the accompanying shales were Upper Silurian. Later, the present author wrote a paper (1941) on the *Panenka-Styliolina* beds, which he called Jordanian, and which come between the Melbournian and the Yeringian series, as is clearly seen on the Walhalla synclinorium. These beds Chapman formerly considered to be probably Lower Devonian in age (1928). Although he was not right in considering that they came above the Yeringian series, yet the fact that he was brought to believe them to be Lower Devonian, or at least uppermost Ludlow, by reason of their palaeontological content, is not without significance. There is a considerable thickness of these beds in the Upper Yarra district between the graptolite-bearing Melbournian rocks and the Yeringian strata. As the Melbournian beds are definitely Lower Ludlow, and the Jordanian series comes between them and the Yeringian strata, then a Lower Devonian age for part at least of the Yeringian series is seen to be not unlikely.

However, the Lower Devonian age of the Yeringian shales and sandstones at Lilydale can now be demonstrated, largely through the discovery of a well-preserved faunule at Hull-road, Mooroolbark (*vide* Gill, 1941). It is now possible to correlate the Lilydale beds with the Baton River (Lower Devonian) beds of New Zealand, described by Shirley (1938). It should be noted

that Thomas (1937, p. 67) has indicated the Devonian aspect of Yeringian beds at Heathcote. Here follows a preliminary palaeontological survey of some of the fossils which are of special significance stratigraphically.

Phylum PORIFERA.

Class HEXACTINELLIDA.

Genus **Receptaculites** Defrance, 1827.

Receptaculites australis Salter.

(Plate V., figs. 2, 4, 5.)

Receptaculites australis Salter, 1859, p. 47, pl. x., figs. 8-10.
Receptaculites australis Etheridge and Dun, 1898, pp. 62-75, pls. viii.-x.
Receptaculites australis Chapman, 1905, pp. 7-12, pl. ii., figs. 2, 4-7; pl. iii.; pl. iv., figs. 2-7.
Receptaculites australis Shirley, 1938, pp. 461-463, pl. xl., figs. 1-4.

A specimen referable to this species has been collected from the brownish shales of Hull-road, Mooroolbark. The characteristic rhomboidal plates of this fossil are seen in Plate V., fig. 5. The counterpart is reproduced in fig. 4, where the holes representing the pillars of the original sponge can be seen to terminate in the centres of the plates. Fig. 2 shows a cross-section of these moulds of pillars. Shirley has recorded this fossil from the Baton River beds of New Zealand, and regarded it as a "suggestive link" with Eastern Australia. He comments—"*Receptaculites australis* was regarded by Etheridge and Dun as of Middle Devonian age, although some of their localities suggest a 'Yeringian' age." I agree. Such places are Molong and Wellington in New South Wales. One is not aware of any place where *R. australis* has been collected from rocks of Silurian age. David (1914, p. 265) refers to *Receptaculites* as a conspicuous and characteristic fossil of the Devonian rocks of Burrinjuck and Taemas (N.S.W.).

Phylum COELENTERATA.

Suborder TABULATA.

Genus **Pleurodictyum** Goldfuss, 1829.

Pleurodictyum megastomum Dun, 1898.

(Plate IV., figs. 1, 3, 4, 6, 9.)

Pleurodictyum ? problematicum Foerste, 1888, pp. 132-5, pl. xiii., fig. 22.
Pleurodictyum megastomum Dun, 1898, p. 83, pl. 3, fig. 1.
Pleurodictyum megastomum Chapman, 1903, p. 105, pl. xvi., figs. 2-5.
Pleurodictyum megastomum Chapman, 1921, p. 216, pl. ix., figs. 4-6.
Pleurodictyum megastomum Allan, 1929, p. 322.
Pleurodictyum megastomum Withers, 1932, pp. 15-21, text-figs. 1-6.
Pleurodictyum megastomum Shirley, 1938, pp. 463-464, pl. xl., figs. 5-8.

Shirley (1938) has recorded this coral from the Lower Devonian of New Zealand, and has supplemented the developmental series described by Withers (1932). The youngest stage

so far described is the five-celled stage mentioned by Shirley. A three-celled stage from Syme's Tunnel, Killara, is now illustrated (Plate IV., fig. 6), and the sizes of the corallites suggest the order of development. Three-celled stages have also been collected from Ruddoek's Corner and Dixon's Creek (Military Map, Yan Yean, 438,602). From the specimens photographed by Shirley, and from others in the author's collections, it appears that cells four and five are developed at nearly the same time, judging by their size. Five-celled stages have not been recorded previously from Victoria, but the author has found such at Hull-road, Mooroolbark; Ruddock's Corner; and Wallan-road, north of Woodstock (Military Map reference, Yan Yean, 057,742). The largest number of corallites in any specimen so far recorded is sixteen, but in Plate IV. a 19-celled stage (fig. 4), a 22-cell stage (fig. 9), and a 28-cell stage (figs. 1, 3) are shown. These three specimens come from Syme's Tunnel, Killara, from "Flowerfield" Quarry, and from north of Lilydale respectively. A 22-cell stage has also been collected from north of Lilydale. The examination of a large series of specimens has shown that the surface of the tabula is pustulose over its whole area (*contra* Chapman, 1903, p. 106). Infiltrations from the surrounding rock often penetrate the cavity left by the leaching away of the coralline material, and obscure the pustulosity round the edges of the fossil. *Pleurodictyum megastomum* has many *points d'appui*. Specimens have been found appended to crinoid stems, *Lindstroemia*, *Orthoceras*, *Pleurotomaria*, and *Spirifer* (*vide* Plate IV., fig. 3). As Allan's survey (1929) of *Pleurodictyum* shows, the genus is a typically Devonian one. *P. megastomum* is in rocks of Devonian age in New Zealand which were formerly thought to be Silurian. I regard all the *P. megastomum* localities so far described in Victoria as belonging to the Yeringian series, and to be of Devonian age. New recordings of the occurrence of this fossil in the type Yeringian series are Hull-road, Mooroolbark; Melbourne Hill, Lilydale; "Flowerfield" Quarry, Coldstream; and west of Lilydale cemetery. Its earliest appearance in the type series is at Ruddock's Quarry (where it is plentiful), and it occurs through to the youngest of the shales at Hull-road, Mooroolbark. It has not been found in the calcareous strata of Cave Hill, nor in the plant-bearing beds at Hull-road, Lilydale. The beds from the Warrandyte conglomerate as far as Ruddock's Quarry are apparently unfossiliferous, and therefore the absence of *Pleurodictyum* from them can be given no significance.

Phylum BRACHIOPODA.

Genus **Schizophoria** King, 1850.

Schizophoria provulvaria (Maurer).

(Plate VI., fig. I.)

Vide Maillieux, 1936, for synonymy to that date.
Schizophoria provulvaria Shirley, 1938, p. 465, Pl. XL., figs. 10-13.

Outline sub-circular to transversely oval. Ventral valve slightly convex, and dorsal valve much more convex than ventral one. Ventral valve interior: teeth strong, and produced into dental plates which diverge at an angle of about 80 degrees. The plates continue as low ridges following the perimeter of the muscle impressions. The muscle impressions are flabellate, and about half the length of the shell. Their proportion of width to length is approximately 2:3. Vascular markings generally radial, except the two main trunks passing forward from the divaricator impressions. As Shirley remarks, the structures become thicker and heavier with increasing age. No well-preserved dorsal valve has been collected, but those obtained show the widely-divergent crura and crural plates found in *Schizophoria provulvaria*. This fossil has been collected from Hull-road, Mooroolbark; Melbourne Hill, Lilydale; north of Lilydale; Wilson's (near Lilydale); Ruddock's Corner; and ? Ruddock's Quarry.

Schizophoria provulvaria is characteristic of the Silurian and Lower Coblenzian of Europe. Its occurrence ranges geographically from the Lower Devonian of England (Lloyd, 1936) to New Zealand (Shirley, 1938), and its discovery in Victoria now adds another link to the chain of known occurrences. Similar species, *S. striatula* (Ruedemann and Balk, 1939) and *S. vulvaria* (Schuchert and Cooper, 1932) have been recorded from the Devonian of North America. Etheridge (1902) has recorded *S.* nr. *striatula* from Sandy's Creek, Gippsland, Victoria.

Genus **Fascicostella** Schuchert and Cooper, 1931.

FASCICOSTELLA GERVILLEI (Defrance).

(Plate VI., figs. 3-5.)

For synonymy, *vide Shirley*, 1938. This species, which is a component of the N.Z. Baton River beds, is found in the Yeringian type strata. The description given by Shirley (1938, pp. 466-467) is applicable to the Victorian specimens, which have the same characteristic external ornament and internal structures. The furrowed dental sockets can be seen in specimen No. 1729 (Reg. No., Univ. of Melb. Geol. Dept. Mus.).

Shells referred by Chapman (1914*a*, p. 224) to "*Orthis*" *actoniae* Sowerby belong to this genus, and probably to this species. The specimens are in the National Museum, and come from Killara ("Junction of the Woori Yallock and Yarra"). A careful revision of the fauna is beginning to show that there is not present such a mixture of faunas of different ages as was formerly supposed.

Schuchert and Cooper (1932, p. 130) regarded *Fascicostella* as an essentially European genus. It is interesting to find its occurrence in the Lower Devonian of both New Zealand and

Australia. *F. gervillei* is known from the following localities in the Yeringian type area: Ruddock's Quarry; Ruddock's Corner; Melbourne Hill, Lilydale; and Mitchell's Paddock, Lilydale.

Genus **Anoplia** Hall and Clarke, 1892; Emended Schuchert, 1913*b*.

ANOPLIA AUSTRALIS, sp. nov.

(Plate IV., fig. 8.)

Shell small, sub-semicircular, concavo-convex. Hinge-line straight, approximating to greatest width of shell. Ventral valve convex, flatter on lateral areas, which extend from the position of the interior lateral septa to the lateral margins of the shell. Cardinal extremities approximately right angles. Surface smooth. Spines absent. Cardinal area full width of shell, well-developed at beak, but tapering away towards the cardinal extremities. Beak strong, fairly sharp, projecting beyond the cardinal line. Interiorly, a long median septum traverses about three-quarters of length of valve, and terminates abruptly. Lateral septa or ridges of similar length to the median septum make an angle of about 45 degrees with the latter. Muscle scars not seen. Dorsal valve concave, with flattened lateral areas corresponding with those of ventral valve. Outline same as ventral valve. Surface smooth. Cardinal area linear. Median and lateral septa corresponding with those of ventral valve. Measurements of type specimen: Length (excluding beak) 4 mm., width 6 mm. Discussion: The blunt septa seen in this new species are characteristic of *Anoplia* (Schuchert, 1913*b*, pp. 339, 340). The lateral septa or ridges apparently enclose the muscle areas. They strengthen the shell, increase the area for the attachment of muscles, and also provide a new angle of muscle attachment. Except for the present author's references in recent papers to "*Anoplia*, sp. nov." the genus has not been recorded from Australia before (Gill, 1940*b*, 1941). As far as the writer is aware, the genus has not been recorded outside of America before. There are two species known (Schuchert and Maynard, 1913), *A. helderbergiae*, belonging to the Lower Devonian, and *A. nucleata*, belonging to Lower and Middle Devonian formations. The discovery of *Anoplia* in Yeringian beds is a further indication of their Devonian age, and a further link with the American fauna. *A. australis* is not closely comparable with either of the American species. Variation has been noted in the new species in the size of the cardinal angles, and so too in the profile of the lateral margin.

Occurrence: The type specimen (lodged in the University of Melbourne Geological Museum, reg. No. 1720) is from the impure limestone of Seville Quarry (Military Map, Ringwood, 497,413). This species is common in the type Yeringian strata,

and the type is taken from another source because of its preservation of both valves *in situ*. *Anoplia australis* has been collected from the following localities, all of Yeringian age: Ruddock's Quarry; Ruddock's Corner; "Devon Park" North; Victoria-road cutting; Hull-road, Mooroolbark; Syme's Tunnel, Killara; west of Yankee Jim Creek; Watson's Creek (Gill, 1941, p. 158); Howe's Creek Quarry (Parish of Loyola, sect. 132); quarry on track south from Hume Vale–Tommy's Hut road, Kinglake, about one-quarter of a mile west of Tommy's Hut; north of Ruddock's (this is a new locality, consist of a small cutting directly north of Ruddock's Quarry, on the road which proceeds west to Wonga Park from Edward-road).

ANOPLIA WITHERSI, sp. nov.

(Plate IV., fig. 7.)

This species is similar to *Anoplia australis* except that it possesses in both valves five interior septa instead of three. On each side of the median septum there is an extra septum or ridge between the median septum and the lateral septa or ridges. These accessory ridges are much shorter than the others, and do not extend far enough to meet them.

Measurements of type specimen: Length of shell (not including beak) 3·2 m.m., width of shell 3·8 mm. The type specimen is lodged in the Geological Museum of the University of Melbourne (reg. No. 1721), and was collected from Syme's Tunnel, Killara.

A. withersi is named after Mr. R. B. Withers, M.Sc., Dip.Ed., who has collected *Anoplia* in the Kinglake district, and kindly submitted the material to the author.

A. withersi is widely distributed, but is not so common as *A. australis*. It has been collected from the following localities: Ruddock's Quarry; north of Ruddock's; Ruddock's corner; west of Yankee Jim Creek (Upper Yarra District); Syme's Tunnel, Killara.

Genus **Hipparionyx** Vanuxem, 1842.

HIPPARIONYX MINOR Clarke, 1909.

(Plate V., figs. 1, 10.)

(Plate VI., fig. 2.)

Shirley (1938) has described this species from the Baton River beds of New Zealand, and the Victorian specimens are very similar. Like the Baton River specimens, those now figured have a finer ornament than the ones illustrated by Clarke (1909). Most of the specimens obtained have the same fineness of ornament as those described by Shirley (18 ribs in 10 mm.). Two others have a still further finer ornament of 22 ribs in 10 mm. (*vide* Plate V., fig. 10). Examples of both kinds have been obtained from north of Lilydale. Apparently they are two

varieties of the species. *Hipparionyx minor* has been collected from north of Lilydale; Wilson's (Cresswell Coll.); Melbourne Hill, Lilydale; Hull-road, Lilydale; and Hull-road, Mooroolbark. The variety of *H. minor* with the finer ornament is found in the first and last of those localities. One shell figured (Pl. V., figs. 1, 10) belongs to this variety, and comes from Hull-road, Mooroolbark. It possesses the fine concentric ornamentation absent from the interspaces, which Shirley mentions (p. 472). Plate VI., fig. 2, is an internal cast of a dorsal valve from Wilson's, Lilydale (in the Cresswell Collection housed in the National Museum), and it possesses an ornament comparable with that of the Baton River forms.

Genus **Leptaena** Dalman.

Leptaena rhomboidalis (Wilckens).

(Plate V., figs. 3 and 8.)

Leptaena (*Leptagonia*) *rhomboidalis* McCoy, 1877. pp. 19-20, Pl. xlvi., fig. 1.

? *Leptaena rhomboidalis* Chapman, 1913, p. 102, Pl. x., fig. 3. *non* pp. 103-104, Pl. x., figs. 4-7.

As the synonymy of this ubiquitous species is well known, it is not given here. References to descriptions of specimens in Victoria are alone provided.

Description of dorsal valve from Hull-road, Mooroolbark: Shell sub-quadrilateral, the anterior margin being about parallel to the hingle-line. Hinge-line equal to greatest width of shell. Cardinal angles sub-auriculate. Cardinal area linear. Valve slightly concave for approximately three-quarters of its length, and then deflected abruptly dorsalwards. External surface marked by distinct concentric rugae on the flattish posterior part, but not on the geniculated anterior portion. Very numerous fine radiating striae extend the full length of the shell, crossing the rugae without interruption. Interior surface finely and closely papillose, the papillae being streamlined posteriorly into minute ramps which are aligned more or less with the direction of the external striae. Cardinal process double; extends beyond the hinge-line. Shallow crural bases continue as low ridges defining a large pair of posterior muscle scars (posterior adductors) and a much smaller pair (anterior adductors) which lie immediately in front of the former. The anterior adductors are separated by a thin median septum which terminates anteriorly in a prominent knob. The posterior adductors are separated by a comparatively wide but low median septum. After traversing three-quarters of the length of the scars, this septum lowers rapidly into a well-marked depression, which further forward gives place to the thin septum dividing the anterior adductors.

This shell conforms to the Helderbergian type of *Leptaena rhomboidalis* (Hall and Clarke, 1892, Plate VIII., figs. 20-27; Grabau and Shimer, 1909, p. 226, fig. 273*b*) with well-developed

internal features. It also has many points of similarity with specimens figured by Barrande from Bohemia (1879, Plate 41, figs. 25 and 30).

In 1913, Chapman (*vide* synonymy) claimed to have discovered a denticulate hingle-line on a specimen of *Leptaena rhomboidalis* from Loyola. The specimen, reg. No. 124301, National Museum, probably belongs to this species, but the hinge-line is not denticulate. Chapman also described two other fossils, reg. Nos. 12402 and 12403, as specimens of *L. rhomboidalis*, showing brachial impressions. However, the writer does not regard these determinations as correct.

Genus **Stropheodonta** Hall, 1852.

Stropheodonta bipartita (Chapman).

(Plate V., figs. 7 and 9; Pl. VI., fig. 10.)

Chonetes bipartita Chapman, 1913, pl. x., figs. 8, 9, 10.

This brachiopod does not belong to the genus *Chonetes* because it is devoid of spines. Large numbers from many localities have been collected, and if spines were present, at least the bases of the spines would have been preserved on some of the specimens. However, the cardinal margins of all are quite smooth.

Actually, the shell is a *Strophcodonta*, having a finely denticulate hinge-line. This fine denticulation is clearly preserved in the brachial valve, which is one of the co-types of the species. *S. bipartita* is of the "*Strophomena*" *comitans* Barrande type. This latter fossil is a widely distributed Lower Devonian species originally described from Bohemia. Besides occurring in Europe, it is known from the Lower Devonian of Burma (Reed, 1929). A comparable form has been recorded from Indochina (Mansuy, 1916, Plate II., fig. 2, *a* and *b*). It is interesting to note that some of the specimens of *S. comitans* figured by Barrande are bipartite (Barrande, 1879, Vol. V., Plate 56, figs. 19, 20). As in *S. comitans*, *S. bipartita* also has a denticulate hinge-line for approximately half the distance between the umbo and the cardinal extremities. Both species are fully papillose interiorly, and possess a comparable musculature. The two co-types and the paratype which Chapman selected when describing "*Chonetes*" *bipartita* are all internal impressions. The external ornament on both valves consists of about 25 ribs radiating from the umbo, with two to six fine intermediate riblets between each pair of ribs.

S. bipartita is very widely distributed in the Yeringian series, and in some places is present in immense numbers (e.g., Ruddock's Quarry). The species is not known from outside the Yeringian beds and constitutes a good index fossil for the series.

Genus **Eospirifer** Schuchert, 1913.

Eospirifer sp.

(Plate VI., figs. 8 and 9.)

The two specimens figured are the only two which have been found. They are significant because they are clearly of the *E. togatus* (Barrande) type, which species is common in the Lower Devonian of New Zealand.

Genus **Cyrtinopsis** Scupin, 1896.

Cyrtinopsis perlamellosus (Hall).

(Plate VI., figs. 6, 7.)

Spirifer perlamellosa Hall, 1857, p. 57, figs. 1-2.

Spirifer perlamellosus Hall, 1859, p. 201, pl. xxvi., figs. 1a-1s, 2a-2g.

Spirifer perlamellosus Hall and Clarke, 1894, pp. 15-17, pl. xxxv., figs. 7-13.

non *Spirifer perlamellosus* var. *densilineata* Chapman, 1908*a*, pp. 223-224, pl. iv., figs. 1 and 2, pl. v.

Spirifer perlamellosus Grabau and Shimer, 1909, p. 321, fig. 407.

Cyrtinopsis perlamellosus Shirley, 1938, pp. 482-483, pl. xliv., figs. 9-10.

Shirley's description is applicable to specimens of the above species collected from Hull-road, Mooroolbark. In Plate VI., fig. 7, the high cardinal area is seen in a mould which shows horizontal striations, those on the deltidial plates being finer than those on the rest of the area. Although Hall (1859) does not refer to it in his description, he shows in his Plate 26, fig. *2f*, that the interior of the ventral valve is papillose in the umbonal region. One of our specimens shows a similar papillosity.

Chapman (1907, p. 239) recorded from Kilsyth "*Spirifer perlamellosus*, J. Hall, var. nov. (= *S. sulcatus*, McCoy, *non* Hisinger)." Later (108, p. 223), he altered his determination of these fossils to "*Spirifer sulcatus*, Hisinger sp." He wrote, "In a former paper, giving a list of Silurian (Yeringian) fossils from the Croydon district, I included a spirifer there referred to as *S. perlamellosus*, var. nov., and bracketed it with *S. sulcata*. The small examples of the new variety *densilineata* show certain marked affinities with those figured by McCoy under Hisinger's specific name, and at the time it seemed highly probable that they made a continuous series of one variable species. A further examination of a large number of Yeringian spirifers shows, however, that McCoy was right in regarding his specimens from Yering as identical with Hisinger's species, the chief and fairly constant differences between the two forms *S. perlamellosus*, var. *densilineata*, and *S. sulcatus* being the higher delthyrium the closer lamellation, more numerous plications, and interrupted striae of the latter. The Croydon examples should, therefore, be referred to *Spirifer sulcatus*, Hisinger sp." The Kilsyth fossils are not really comparable with the variety *densilineata* because the latter belongs to a different genus. The internal and external characters of the Kilsyth fossils show them to belong to *Cyrtinopsis perlamellosus*.

McCoy's fossils referred to *Spirifera sulcata* in the Prodromus (1877, p. 23) probably should be referred to *Cyrtinopsis perlamellosus*. He was inclined to regard the latter as a New York "local variety" of *S. sulcata*. The internal structure is not shown in his specimens, but the high area and deep sinus are very much like those of *C. perlamellosus* found further south in the same series.

Chapman (1908*a*, p. 223) described from the Whittlesea district what he considered to be a new variety of *C. perlamellosus*, to which he gave the name *densilineata*. Actually, the specimens are not referable to the genus *Cyrtinopsis* because there are not "dental lamellae converging and united with the median septum" (Schuchert, 1913, p. 413). This is seen clearly in Plate IV., fig. 2. Also, the shells are not "concentrically marked by strong imbricating lamellae, which are abruptly arched in passing over the plications" (Hall, 1859). This can be seen from Chapman's own photographs (Plate V.). More or less concentric rugae are often present on these shells, but not lamellae. Some of the rugae are the result of crushing. The majority are apparently due to irregularity of growth. Most of them traverse only a part of the shell. Moreover, the fine striations are not limited to lamellae as they are in *C. perlamellosus*, but proceed unbroken down the entire length of the shell (see Chapman's Plate V., fig. 3). Chapman provides no description of Plate IV. on which are drawings of reconstructed shells. The drawings show even and regularly-spaced lamellae such as do not appear on the type specimen, or on any specimens which the author has examined. The deltidial plates are much bigger than shown. The three specimens shown in the photographs of Plate V. are all dorsal valves. Chapman's form is referable to the genus *Eospirifer* Schuchert (1913, p. 411). The genus is thus defined: "Quadrate and alate early Spirifers that are either smooth, radially undulate, or plicate, but without plications on fold and sinus. Surface with additional fine, filiform, radiating striae which may be minutely crenulate or granulose. Dental lamellae present." Shirley (1938, p. 476) has slightly modified and extended this description. Chapman's form may now be known as *Eospirifer densilineata* (Chapman).

Genus **Nucleospira** Hall, 1859.

Nucleospira cf. marginata Maurer.

(Plate IV., fig. 5; Pl. V., fig. 6.)

Maurer 1886 (not viewed).
Beushausen 1897, p. 289, pl. v., figs. 8-12.
Shirley 1938, p. 481, pl. xliv., figs. 6-8.

Judging by Beushausen's figures, the Victorian specimens are not specifically separable from Maurer's species. They are very like those described by Shirley from the Baton River beds of New Zealand. Ventral muscle impressions are similarly striated,

and the median septum commonly (but not always) thickens into a bulb at the anterior end. Quite often the small, oval adductor impressions of the ventral valve are distinctly separated from the divaricators. Some of the shells have growth lines on them like those figured by Beushausen. The same author states that although *N. marginata* is usually transverse-oval in outline, some of the specimens are longer than broad. These variations have been noticed in Victorian specimens. McCoy noted this same variation of outline in *N. australis* where the sub-circular profile is the commoner. The measurements of the figured specimens are: Plate IV., fig. 5, 5 mm. long by 6 mm. wide. Plate V., fig. 6, 5 mm. by 5 mm.

N. cf. *marginata* has been collected from Warrandyte South Quarry basal conglomerate, Williamson's-road, Doncaster, north of Lilydale, and Hull-road, Mooroolbark. At the last-named place this fossil is very abundant. Specimens from Warrandyte South Quarry have the same general proportions as those from higher horizons, but are typically smaller, and the anterior bulbous swelling of the median septum is absent. The ventral divaricator scars are striated. Other details are difficult to determine because of the poor preservation.

Genus **Karpinskya** Tschernyschew, 1885.

Karpinskya(?) fimbriata (Chapman).

Atrypa fimbriata Chapman, 1913, p. 109, pl. xi., fig. 15.

This species is not referable to the genus *Atrypa* because it possesses a dorsal median septum. *Karpinskya* is a genus of *Atrypa*-like shells having a dorsal median septum. The genoholotype, *K. conjugula*, however, is elongate, while the species under discussion is sub-circular in outline and possesses marginal spines. Chapman compared his genus with *A. hystrix* and *A. spinosa*. It resembles the former in the development of marginal spines. The species is referred with question to *Karpinskya* because, although it possesses the characteristic (*vide* Schuchert, 1913, p. 409) dorsal median septum of that genus, it differs in the presence of marginal spines and in its proportions.

Karpinskya is a Lower Devonian genus, the genoholotype being described from beds of that age in Russia. The spinose North American species of *Atrypa* are from Middle and Upper Devonian strata. Barrande (1879) figures a spinose, sub-circular species (*A. semiorbis*) from the Lower Devonian of Bohemia (Vol. 5, Plate 34, fig. 22). The holotype of *Karpinskya fimbriata* is from "near Lilydale," which is very probably the locality known as "Wilson's" (for exact location see Gill, 1940*b*). In a collection of fossils at the National Museum, Melbourne, presented by the late Rev. A. W. Cresswell, M.A., there is a specimen of this shell side by side with the specimen of *Hipparionyx minor* figured on Plate VI., fig. 2. This specimen also comes from Wilson's. Some poorly-preserved specimens of *K. fimbriata* have been found at "Devon Park" West.

From Ruddock's Quarry and Melbourne Hill, Lilydale, there have been collected atrypids with marginal spines. These are flat and somewhat elongated, not globose and sub-circular like *K. fimbriata.*

Phylum PELECYPODA.

Genus **Actinopteria** Hall, 1859.

Shirley (1938) describes *Actinopteria* sp. from the Baton River (Lower Devonian) beds of New Zealand, and points out that Pterinoid shells are rare in the Silurian. From the type Yeringian beds the following Pterinoids have been described:—

Actinopteria texturata (Phillips): *A. boydi* (Conrad): *A. asperula* var. *croydonensis* Chapman: *Leiopteria* cf. *oweni* Hall.

These were described by Chapman (1908*b*). Pterinoid shells are common at north of Lilydale; Wilson's; Melbourne Hill, Lilydale; and Kilsyth. They constitute a characteristic element of the Yeringian fauna.

Genus **Cypricardinia** Hall, 1859.

This genus is common in the higher horizons of the type Yeringian series. Chapman (1908*b*) has described *Cypricardinia contexta* Barrande from three localities in the Lilydale district. Shirley has recorded the genus from the Lower Devonian of New Zealand. Barrande's species referred to above occurs in the Lower Devonian of Bohemia.

Phylum TRILOBITA.

Genus **Calymene** Brongniart, 1822.

Sub-genus GRAVICALYMENE Shirley, 1936.

Calymene angustior Chapman, 1915, pp. 164-6, pl. xv., figs. 8-10.
Calymene (*Gravicalymene*) ? *angustior* Shirley, 1938, p. 487, pl. xliv., fig. 17.

Shirley's sub-genus covers a clearly demarcated group which apparently represents a definite line of evolutionary development. It is therefore deserving of generic rank. *Gravicalymene angustior* has been collected in the type area from Ruddock's Quarry, Ruddock's Corner, north of Ruddock's, and Mitchell's Paddock, Lilydale. It is a conspicuous part of the trilobite assemblage. Shirley has described this species from the Lower Devonian beds at Baton River in New Zealand. He suggests (p. 487) that *G. australis* is conspecific with *G. angustior.* A similar form, *G. cootamundrensis,* has recently been described from N.S.W. (Gill, 1940*a*). Mansuy's *Calymene maloungkaensis* from Indochina belongs to this genus, and has affinities with the Australian species (Mansuy, 1916, Plate IV., figs. 4*a-q*).

Genus **Goldius** De Koninck, 1841.

Shirley (1938) records this genus from New Zealand, remarking that it has not been recorded from the austral Lower

Devonian, and so provides further evidence of the biological separation of that province. This separation is a very marked one, and forced itself on the attention of the present writer when investigation of the Lilydale fauna was first undertaken.

The palaeontological data set out in the preceding pages reveal a definite connexion between the Baton River (Lower Devonian) beds of New Zealand and the type beds of the Yeringian Series. This evidence is summarized in the following list of fossils common to both deposits:

> *Receptaculites australis* Salter: *Pleurodictyum megastomum* Dun: *Schizophoria provulvaria* (Maurer): *Fascicostella gervillei* (Defrance): *Hipparionyx minor* Clarke: *Nucleospira* cf. *marginata* Maurer: *Cyrtinopsis perlamellosus* (Hall): *Calymene* (*Gravicalymene*) *angustior* (Chapman).

Further evidence of Devonian age is provided by the presence of

> *Anoplia* spp.: *Karpinskya* (?) sp.: *Eospirifer* of the *E. togatus* (Barrande) type: *Stropheodonta* of the *S. comitans* (Barrande) type.

The foregoing data demonstrate the Devonian age of the Lilydale shales and sandstones, and they show that in part at least they can be correlated with the Baton River beds of New Zealand.

Shirley (1938, p. 490) commented on the presence of *Hipparionyx* and *Cyrtinopsis* as forming a strong link with the North American deposits, since these genera do not occur in the European Lower Devonian. The presence of *Anoplia* in the Yeringian beds strengthens that correlation, for that genus is known only from America and Australia.

The finding of a Devonian age for the Lilydale shales and sandstones is supported by work on the limestone facies by Dr. Ripper (Stromatoporoids) and Dr. Hill (Corals). Originally, it was thought that all the limestone deposits of the Yeringian Series in various parts of Victoria belong to the same horizon. Murray (1887, p. 45) stated that the "various limestone patches" are "clearly identical with one another in geological position". Dun (1889, p. 70) wrote of the Loyola limestone, "It is probably of the same age as the Lilydale limestone." Chapman (1914*a*, p. 211) thought the Seville limestone to be equivalent in age to the Lilydale lenticle. However, Ripper and Hill have shown that the Loyola limestone is somewhat older than that at Lilydale. The Seville limestone is probably also older than the Cave Hill deposit. The limestones of the Walhalla synclinorium occur as lenticles in the basal grits (Whitelaw, 1916, p. 8), and should probably be correlated not with the Cave Hill limestone but with the decalcified limestone of the basal conglomerate seen in the Warrandyte South Quarry. This finds some support from the statement of Jones and Hill (1940, pp. 200, 203, 206, 208) that the limestone at Cooper's Creek (tributary of the Thomson River, Gippsland) is Silurian or perhaps Devonian.

Summary and Conclusions.

1. The Warrandyte South Quarry fossiliferous conglomerate is suggested as a base for the type Yeringian Series.

2. The thickness of the strata as measured from the conglomerate is estimated as being somewhat less than 17,000 feet. Lack of outcrops in some areas prevents a precise calculation. The general form of the structure is synclinorial. The eastern side of the synclinorium is largely screened by the Upper Devonian igneous rocks of the Dandenong Mountains complex.

3. The age of the shales and sandstones is shown to be Devonian. In part at least, these beds can be correlated with the Baton River (Lower Devonian) beds of New Zealand described by Shirley. The fauna reveals definite affinities with the European and North American Lower Devonian faunas. Three genera found in the North American but not European Lower Devonian are present in the Lilydale beds, viz. *Hipparionyx, Cyrtinopsis,* and *Anoplia.* There is little connexion with the austral Lower Devonian faunas of South America and South Africa. The wide admixture of Wenlock to Devonian elements earlier claimed for the Yeringian fauna is found to be untenable upon the re-study of the fauna.

Acknowledgments.

In addition to the acknowledgments made in the text, I wish to express my appreciation of the help of Dr. F. A. Singleton, who accompanied me in the field on some occasions. Drs. E. S. Hills and A. B. Edwards, and Mr. G. Baker, M.Sc., have kindly examined the intrusive rocks mentioned in the paper. I wish to express my indebtedness also to Mr. L. A. Baillot, of the Melbourne Technical College, who has taken much interest in the special problems associated with the photography of palaeontological specimens. Nearly all the photographs in the accompanying plates are his work. None of the photographs has been retouched.

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Description of Plates.

PLATE IV.

FIGS. 1 and 3.—*Pleurodictyum megastomum* Dun from North of Lilydale—counterparts. Fig. 1, mould of corallites. (1711.) Fig. 3, epitheca on *Spirifer*. (1712.) × 2.5.

FIG. 2.—*Eospirifer densilineata* (Chapman) from Cemetery Hill Road, Whittlesea, showing diverging dental lamellae. (1715.) × 1.1.

FIG. 4.—*Pleurodictyum megastomum* Dun. Mould of corallites from Syme's Tunnel, Killara. (1713.) × 1.5.

FIG. 5.—*Nucleospira* cf. *marginata* Maurer. Internal cast of ventral valve from Hull Road, Mooroolbark, showing striated divaricator scars, small oval adductor scars, growth lines, and expanded anterior end of median septum. (1726.) × 4 approx.

FIG. 6.—*Pleurodictyum megastomum* Dun. Three-celled form from Syme's Tunnel, Killara. (1714.) × 2.

FIG. 7.—*Anoplia withersi*, sp. nov., from Syme's Tunnel, Killara. Holotype. Internal cast, ventral valve. (1721.) × 4.

FIG. 8.—*Anoplia australis*, sp. nov., from quarry in impure limestone, Warburton highway, Seville. Holotype. Internal casts of dorsal and ventral valves. (1720.) × 4 approx.

FIG. 9.—*Pleurodictyum megastomum* Dun. "Flowerfield" Quarry. [14103.] × 2 approx.

Plate V.

Figs. 1 and 10.—*Hipparionyx minar* Clarke. Counterparts of ventral valve, from Hull Road, Mooroolbark. Fig. 1, internal cast. (1731.) Fig. 10, external mould. (1732.) × 2.

Figs. 2, 4, 5.—*Receptaculites oustralis* Salter, from Hull Road, Mooroolbark. Fig. 2, cross-section of moulds of pillars. (1716.) Figs. 4 and 5, counterparts showing rhomboidal plates. (1716, 1717.) Fig. 4 shows how the pillars terminate in the centres of these plates. (1716.) × 2.

Figs. 3 and 8.—*Leptaena rhombaidalis* (Wilckens) counterparts, from Hull Road, Mooroolbark. (1718, 1719.) × 2 approx.

Fig. 6.—*Nucleospira cf. marginota* Maurer, from Hull Road, Mooroolbark. (1727.) × 4 approx.

Figs. 7 and 9.—*Stropheodanta bipartito* (Chapman) counterparts, showing internal casts (1725) and external moulds (1724) respectively. Note denticulate hingeline. Specimens from Yellingbo. × 3 approx.

Plate VI.

Fig. 1.—*Schizophorio provulvoria* (Maurer). Internal cast of ventral valve, from Hull Road, Mooroolbark. (1733.) × 2.

Fig. 2.—*Hipparionyx minar* Clarke. Internal cast of dorsal valve, from Wilson's, Lilydale. [14104.] × 1 approx.

Figs. 3, 4, 5.—*Fascicastella gervillei* (Defrance), from Melbourne Hill, Lilydale. Figs. 3 (1728) and 4 (1729), ventral internal casts. Fig. 5, internal cast of dorsal valve. (1730.) × 2.

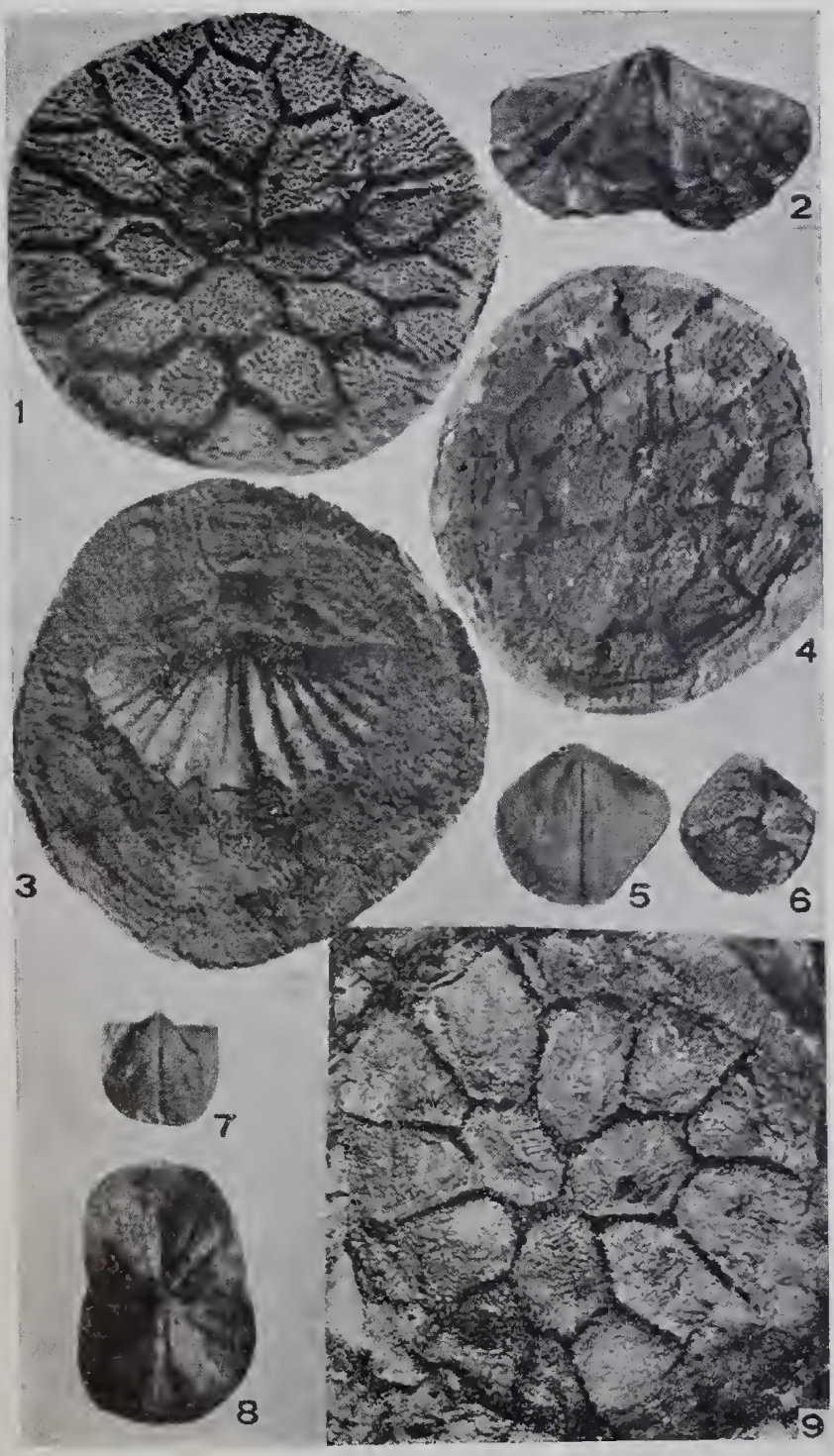
Figs. 6 and 7.—*Cyrtinopsis perlomellosus* (Hall), from Hull Road, Mooroolbark. Fig. 6, external mould, dorsal valve. (1722.) Fig. 7, internal cast of ventral valve with the right half broken away showing the striate cardinal area, and the dental lamellae converging to unite with the median septum. (1723.) × 2.

Fig. 8.—*Eospirifer* sp., from "Lilydale Mudstone" (Cresswell Coll.). [14105.] × 1 approx.

Fig. 9.—*Eospirifer* sp., from Ruddock's Quarry. [14106.] × 1 approx.

Fig. 10.—*Stropheodanta biportito* (Chapman). Enlargement of Pl. V., fig. 9, to show detail of ornament and denticulate hingeline. (1724.) × 7 approx.

Note.—In all descriptions of plates, the numbers in rounded brackets are registered numbers of the University of Melbourne Geology Department Museum. Those in square brackets are registered numbers of the National Museum, Melbourne.



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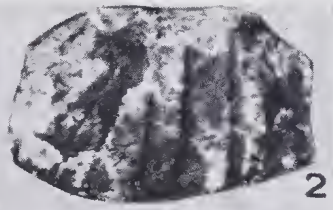
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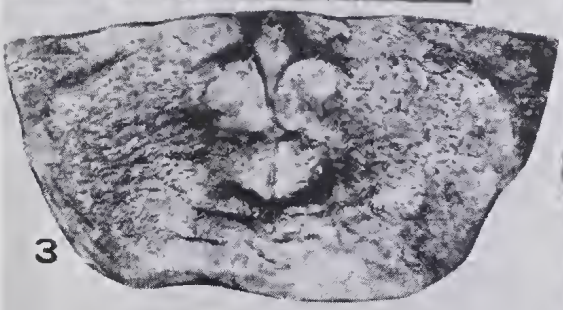
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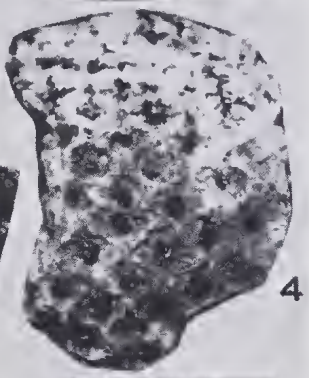
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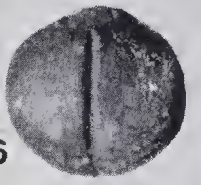
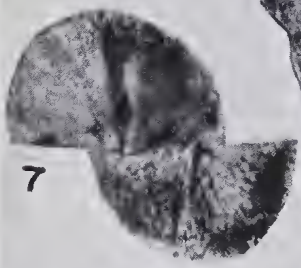

6


8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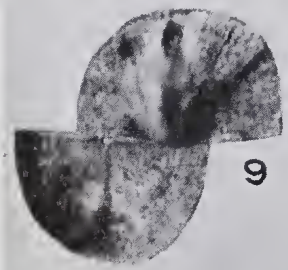
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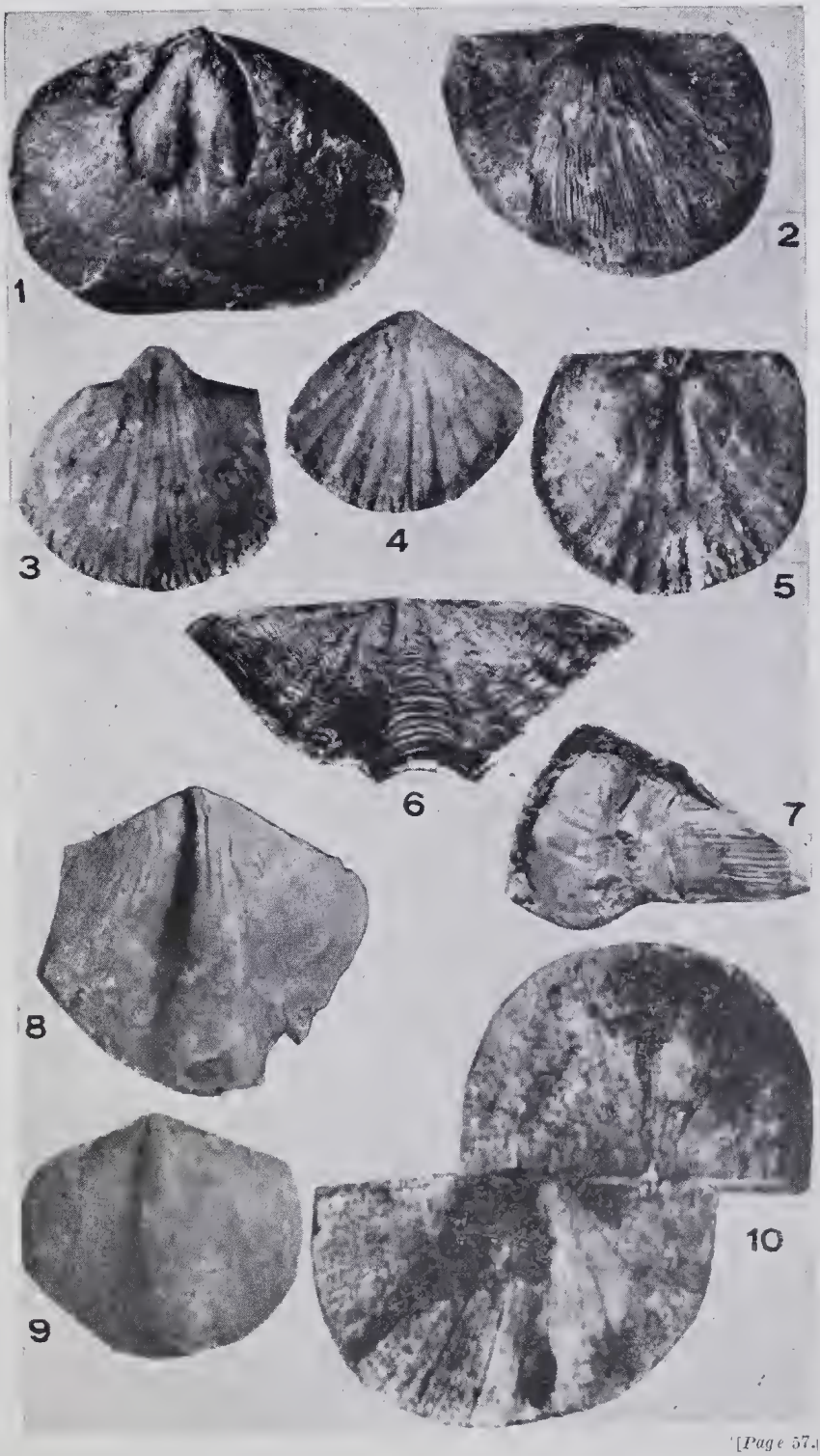

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